Semester	IV	Course Title	Control Systems	Course Code	18 EC 43
Teaching Period	50 Hours	L – T – P – TL*	3 – 1 – 0 – 4	Credits	4
CIE*	40 Marks	SEE*	60 Marks	Total	100 Marks

CREDITS – 04

Course objectives: This course will enable students to:

- Understand the basic features, configurations and application of control systems. Understand various terminologies and definitions for the control systems.
- Learn how to find a mathematical model of electrical, mechanical and electro-mechanical systems.
- Know how to find time response from the transfer function. Find the transfer function via Masons 'rule.
- Analyze the stability of a system from the transfer function.

Module -1

Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems –Mechanical Systems, Electrical Systems, Electromechanical systems, Analogous Systems. **L1, L2, L3**

Module -2

Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs. **L1, L2, L3**

Module -3

Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers (excluding design). **L1, L2, L3**

Module -4

Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh stability criterion, Relative stability analysis: more on the Routh stability criterion. Introduction to Root-Locus Techniques, The root locus concepts, Construction of root loci. **L1, L2, L3**

Module -5

Frequency domain analysis: Introduction, Bode plots, Introduction to polar plots, (Inverse polar plots excluded), Mathematical preliminaries, Nyquist stability criterion, (Systems with transportation lag excluded), Introduction to lead, lag and lead-lag compensating networks(excluding design).

Introduction to state variable analysis: Concept of state, state variable and state models for electrical system, Solution of state equations. **L1, L2, L3**

Course Outcomes: At the end of the course, the students will be able to

- Develop the mathematical model of mechanical and electrical systems.
- Evaluate the transfer function for a given system using block diagram reduction techniques and signal flow graph method.
- Determine the time domain specification for first and second order systems and analyse the working of PID Controller.
- Determine the stability of a system using Routh-Hurwitz criterion and Root-locus technique.
- Determine the stability of a system in the frequency domain using Nyquist, Polar Plots and bode plots and also analyse the system using state variable and state models.

Question paper pattern:

- Examination will be conducted for 100 marks with question paper containing 10 full questions, each of
  20 marks.
- Each full question can have a maximum of 4 sub questions.
- There will be 2 full questions from each module covering all the topics of the module.
- Students will have to answer 5 full questions, selecting one full question from each module.
- The total marks will be proportionally reduced to 60 marks as SEE marks is 60.

Text Book:

- **J.Nagarath and M.Gopal**, – Control Systems Engineering||, New Age International (P) Limited, Publishers, Fifth edition-2005, ISBN: 81-224-2008-7.

Reference Books:

- **Modern Control Engineering,|| K.Ogata**, Pearson Education Asia/PHI, 4th Edition, 2002. ISBN 978-81-203-4010-7.
- **Automatic Control Systems||, Benjamin C**. Kuo, John Wiley India Pvt. Ltd., 8th Edition, 2008.
- **Joseph J Distefano** III et al., Schaum's Outlines, TMH, 2nd Edition 2007.